SMALL-ARMS RANGE

SAR AGENDA

OESO

- Problem Statement
- Regulations, Rules, and Policies
  - Active and inactive
  - Closed and closing
- Lead Mobility
- Active Range
  - Characterization
  - BMPs

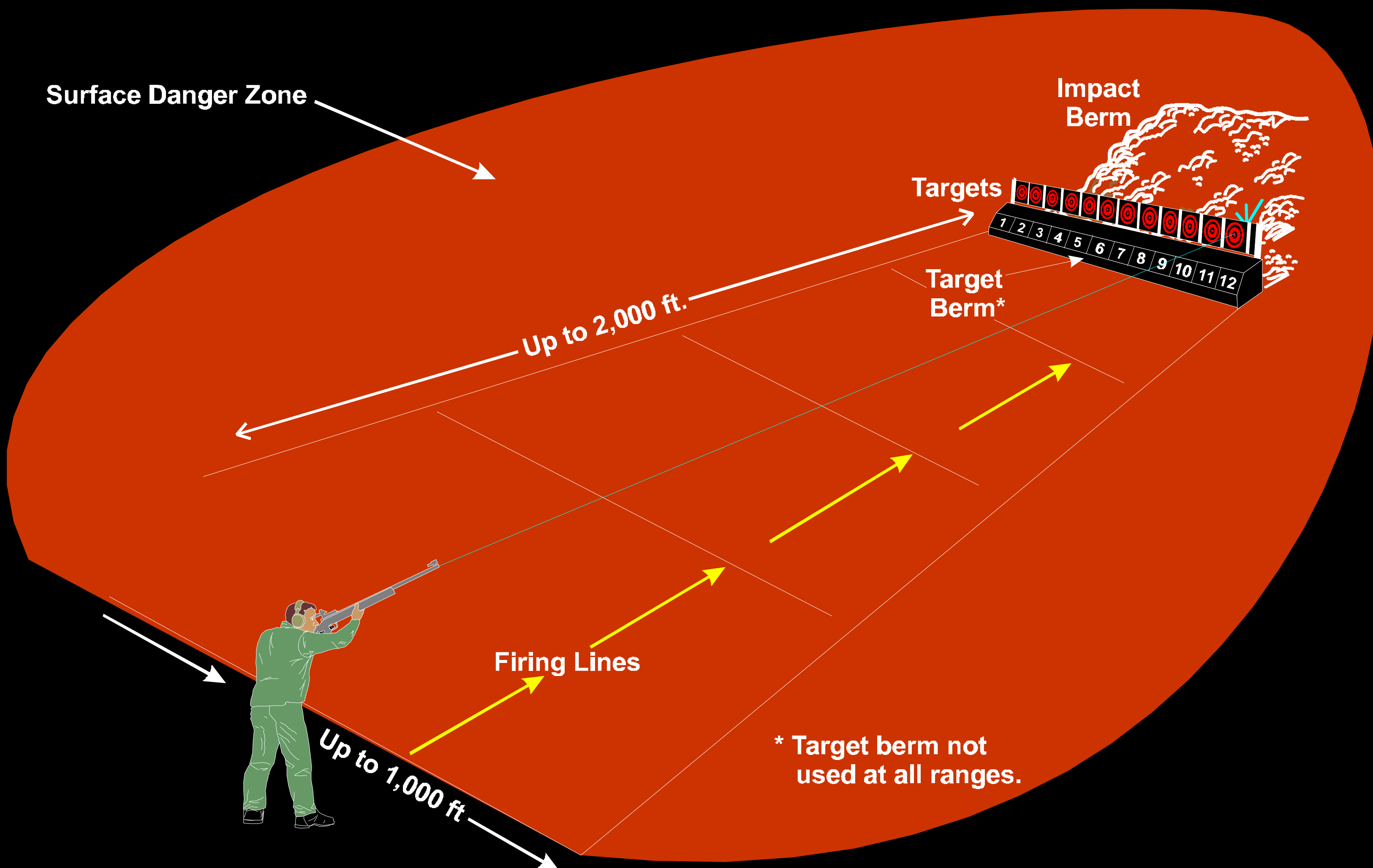
NFESC

- Closed Range
  - Characterization
  - Remediation Alternatives
    - Physical Separation/Acid Leaching
    - Stabilization/Solidification
    - Landfilling
    - Case Studies

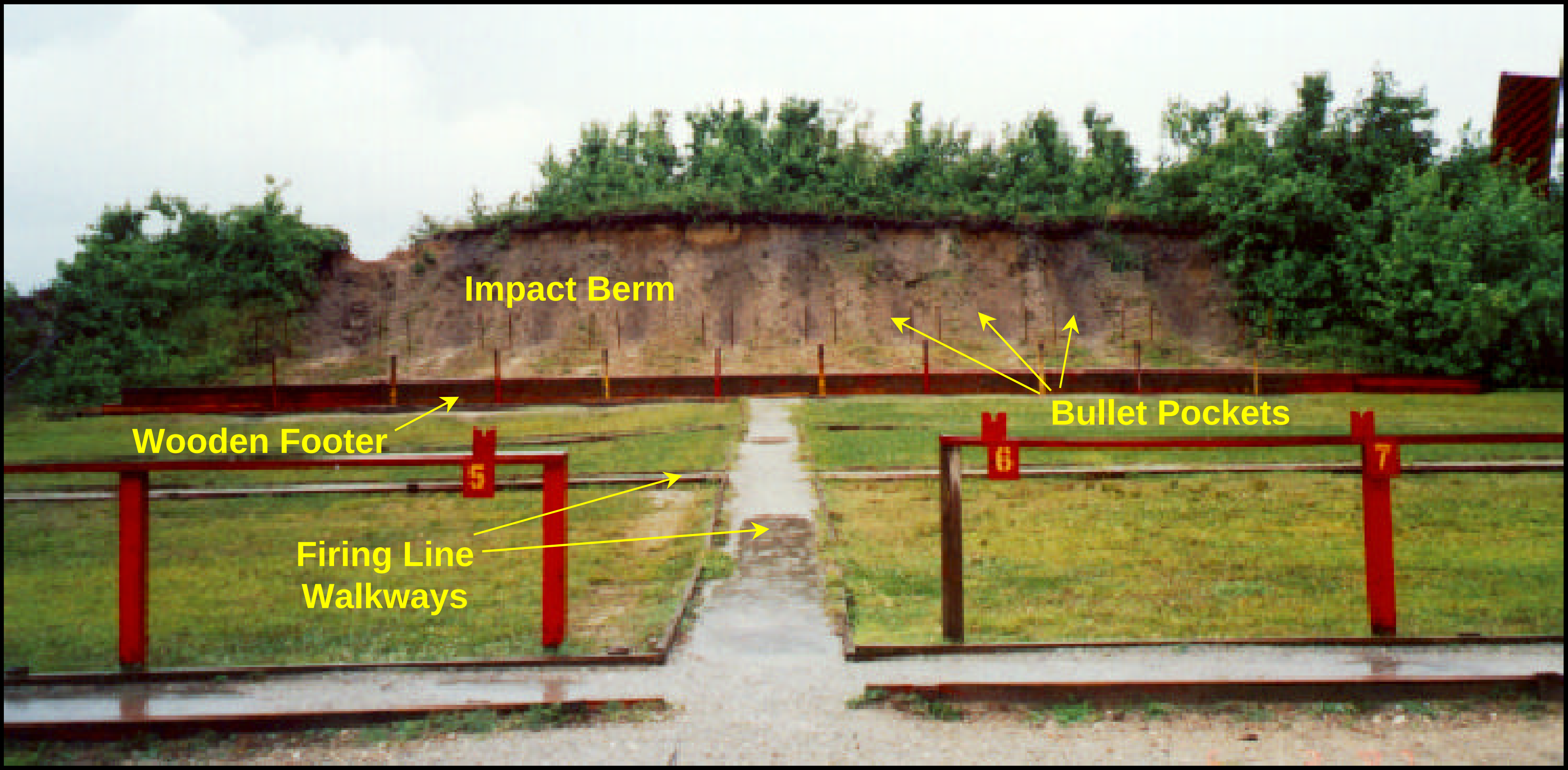
PROBLEM

- “Lead” is a four-letter word.
- Concerns about lead at outdoor shooting ranges may be based on perceptions rather than full awareness and understanding of the scientific processes controlling lead mobility.

TYPICAL SMALL-ARMS RANGE



TYPICAL SMALL-ARMS RANGE



GUIDANCE DOCUMENTS

DOCUMENT	STATUS
EPA Military Munitions Rule	Final Rule Published (62FR6622)
DoD Range Rule	Draft
DoD Application of CERCLA and RCRA to Small-Arms Ranges	Draft
OPNAVINST 3574.1, "Small-Arms Ranges"	Draft
MIL-HDBK-1027/3B	Active: Change 1, 30 June 1995
NAVFACINST 11012.144B, "Small-Arms Ranges (SAR)"	Draft
NAVFACINST 11014.53A, "Navy-Wide Specialized Expertise Program"	Active: 24 April 1996

EPA MILITARY MUNITIONS RULE

- small arms ammunition included in definition of "military munitions"
- reiterates EPA position that use of munitions for their intended purpose does not constitute "discard," and therefore is not a waste management activity
- does not apply to active and inactive ranges

EPA MILITARY MUNITIONS RULE

- “incompatible use” may force formal closure of some ranges on active installations
- postpones final action on the status of military munitions left on closed or transferred ranges until DoD regulations (Range Rule) are promulgated
- DoD regulations must be protective of human health and the environment and allow for public involvement in addressing the ranges.

DoD RANGE RULE

- proposed rule on the “Web” at http://www.acq.osd.mil/ens.
- First phase is identification of all ranges subject to rule (closed, transferred, transferring). Could involve a datacall.

DoD RANGE RULE: DEFINITIONS

- **Closed Range:** A Military Range that has been taken out of service as a range and that either has been put to new uses that are incompatible with range activities or is not considered by the military to be a potential range area. A Closed Range is still under the control of a DoD component.

DoD RANGE RULE: DEFINITIONS

- **Accelerated Responses:** any readily available, generally used, reliable, and easily implemented methods of addressing the risk posed by military munitions, unexploded ordnance (UXO), or other constituents at military ranges. ARs may be fully protective in and of themselves.

DoD RANGE RULE

- **Selection of Accelerated Response:**
  - follow ARs process
  - use nine criteria of the National Contingency Plan
  - address risks based upon reasonably anticipated future land use
  - Range Rule Risk Model under development. "Other constituents" (non-UXO) handled under other regulatory authority (such as CERCLA or RCRA).

DoD RANGE RULE

Projected Timeline	Target Date
‣ Range Rule to OMB	June '97
‣ Proposal in Federal Register	August '97
‣ Public Involvement Forums (4 regional)	Sept.-Nov. '97
‣ Publish Final Range Rule	Early '98

SYNOPSIS OF DRAFT DoD SAR POLICY

- act of firing a projectile is not “discarding”
- metals recovered during range maintenance recycled
- minimize possibility of releases of hazardous substances through “management practices”
- active and inactive small-arms ranges should not be subject to RCRA corrective action
- use CERCLA lead agency authority to respond to releases

CERCLA CONSIDERATIONS

- surface danger zone defines your “facility”
- CERCLA applies to some releases from the facility (range), not to what is happening in/on the facility
- still need to be ready to respond to threat of a release or imminent and substantial danger to public health or welfare

CERCLA CONSIDERATIONS

- Bullets are probably “releasing” minuscule amounts of hazardous substances into the environment with each rainfall event
- Questions to ask:
  - did a reportable quantity of HS leave the facility?
  - do I need to take some action?

CWA CONSIDERATIONS

- U.S. District Court ruled that the New York Athletic Club trap-shooting range constituted a “point source” for purposes of the CWA.
- Shot and target debris constitute “pollutants” within the CWA.
- NYAC range cannot operate until it gets a NPDES permit.
- Impact of this ruling is unknown.

CWA CONSIDERATIONS

- A “point source” is “any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, ..., from which pollutants are or may be discharged.”

- Be careful not to create a point source when trying to solve other problems.

LEAD MOBILITY

- Lead on an outdoor shooting range could become mobile through physical transport or geochemical processes.
- Physical transport may alter the distribution of lead at a site over time, but not have a substantial effect on bioavailability.
- If metallic lead is transformed to dissolved phases, it is subject to potential transport and uptake by aquatic organisms, birds, mammals, and humans.

LEAD MOBILITY: PHYSICAL TRANSPORT

- Soil erosion and sediment transport in surface runoff could create an exposure pathway for lead to impact wildlife or water quality in areas adjacent to ranges.
- Sediment load can carry ultra-fine particles of lead and lead adsorbed to sediment significant distances.
- Physical transport is controllable with engineering and/or vegetative controls.

LEAD MOBILITY: GEOCHEMICAL PROCESSES

- Processes controlling the fate and transport of lead:
  - precipitation/dissolution
  - adsorption/desorption
  - oxidation/reduction

LEAD MOBILITY: GEOCHEMICAL PROCESSES

- **Metallic lead is insoluble in water, but in the geochemical environment of most ranges will slowly convert to other oxidized forms.**

- **Depending on the microenvironment (pH/soil characteristics), oxidation products can become mobile.**

- **Lead mobility will be effectively controlled by adsorption under the majority of conditions found on shooting ranges.**

LEAD MOBILITY: GEOCHEMICAL PROCESSES

- Organic matter in the upper layers of soils has strong capacity to adsorb and retain lead
- Lead that migrates through the upper soil layer is likely removed from solution by adsorption or exchange reactions with clays, metal oxides, or organic matter in the lower soil horizon
- Generally observe an exponential decline in lead concentrations in very short vertical distances

LEAD MOBILITY: GEOCHEMICAL PROCESSES

- In soils with high pH, lead can be expected to be immobilized by precipitation of lead carbonates and hydroxides from solution.

- Lead forms several relatively insoluble phosphate compounds when free phosphate is present in solution.

- The amount of phosphate present in most fertilized soils is sufficient to keep the concentration of lead in solution less than the MCL of 0.05 ppm if pH>5.

LEAD MOBILITY: CONCLUSIONS

- The environmental chemistry of metallic lead is sufficiently well known to understand the basic processes controlling lead mobility.

- Lead mobility is not likely to be a serious problem at most locations based on the typical relationships of the major controlling variables.

*MANAGEMENT PRACTICES

1. determine if lead mobility is a potential problem
2. establish management objectives
3. measure factors controlling mobility

* Implement at active and inactive ranges. OESO developing guidebook.

MANAGEMENT PRACTICES

- May include some combination of the following:
  - prevention of soil erosion from berms, aprons, and other range areas
  - soil amendments
  - recovery/recycling of lead

MANAGEMENT PRACTICES

- Prevention of soil erosion
  - maintain vegetation on berms and drainageways
  - look at site drainage patterns
  - slow rate of runoff and provide sediment traps such as a vegetated detention basin or infiltration area (can use something as simple as a straw bale dike)
  - don’t create any “point source”

MANAGEMENT PRACTICES

- **Soil Amendments**
  - In general, practices that increase the productivity of soil (organic matter, fertilizer, lime) also result in lead immobilization in the soil.
  - maintain pH in the range of 6 to 8
  - consider addition of triple superphosphate or bone meal if it will not affect the water quality of any nearby water bodies
  - consider working organic matter (peat humus or similar material) into soil

MANAGEMENT PRACTICES

- Recovery/Recycling of Lead
  - safety is main driver
  - recommend avoiding anything that looks like treatment (e.g. acid leaching, fixation, etc.)
  - recovered lead goes to lead recycler or smelter
  - soil immediately goes back to same use

CONTAMINANT MONITORING

- ***Do not gather data that do not contribute to a management or operational decision!***

CONTAMINANT MONITORING: SOIL TESTING

- Total concentration of lead alone has little or no bearing on mobility or bioavailability
- Toxicity Characteristic Leaching Procedure is not technically appropriate for predicting lead mobility
- TCLP designed to simulate conditions that typically occur in municipal landfills

CONTAMINANT MONITORING: SOIL TESTING

- A more appropriate test for predicting mobility is the Synthetic Precipitation Leaching Procedure,
  EPA Method 1312.

- SPLP assesses the potential for contaminants to be leached from soil under conditions simulating acid rain.

CONTAMINANT MONITORING: WATER TESTING

- **Dissolved lead concentration (filtered through a 45-micron filter) should be used to compare with water quality standards**

- **EPA position is that dissolved metal approximates the biologically available fraction of waterborne metals for aquatic organisms better than total recoverable metal (60FR22228, 4 May 95)**

CONTAMINANT MONITORING: WATER TESTING

- It would not be unusual to detect lead in stream sediments but not in the water

- Stream sediments usually contain a great deal of clay and variable amounts of organic matter and iron and manganese oxides. These all have the capacity to retain lead adsorbed prior to being eroded from soil and also adsorb additional lead from stream water.

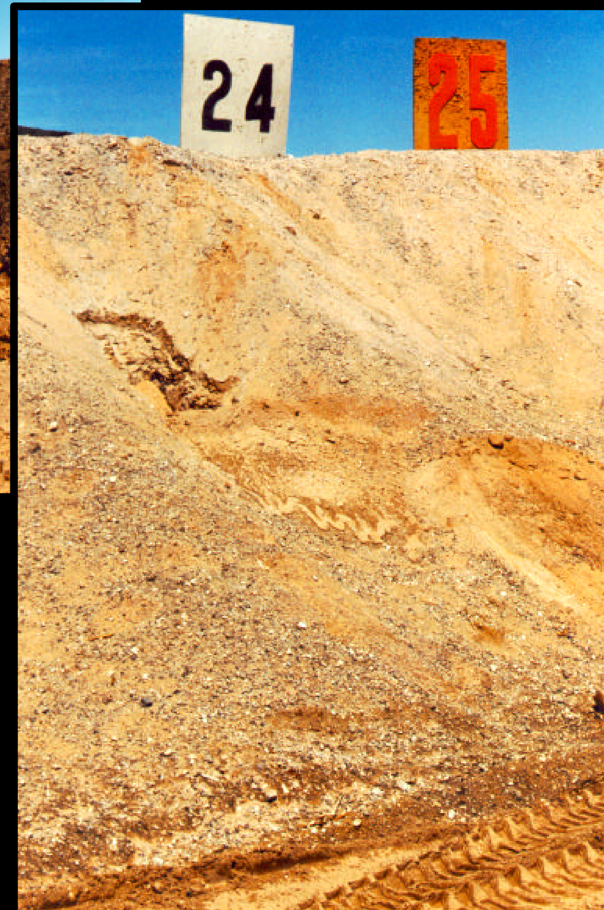
CLEANUP LEVELS

- Cleanup levels drive remediation technology needed (if any)
  - Future land use
  - Risk
  - Regulatory interpretation

SITE CHARACTERIZATION/RISK ASSESSMENT FOR CLOSED RANGES

- Understand the full extent of metal contamination
  - Location of contamination
  - Concentrations of contamination
  - Metals speciation
- Soil particle size distribution
- Lead distribution by particle size
- Soil properties (pH, cation-exchange capacity, total organic carbon, bulk density)
- Presence of co-contaminants
- Location of receptors

SITE CHARACTERIZATION



DETERMINING REMEDIATION TECHNOLOGY

- Amount of soil to process
- Location of the soil (number of sites)
- Type of soil (clay, sand, etc…)
- Site characterization results
- Cleanup levels

REMEDIAL ALTERNATIVES

- Transfer property as is
- Physical Separation/Acid Leaching (PS/AL)
- Stabilization/Solidification (S/S)
- Landfilling

PHYSICAL SEPARATION/ACID LEACHING

- **Physical separation**
  - **Removes coarse particulate metals**
  - **Uses differences in particle size and density**
  - **Wet processes; the particles suspended in a slurry**
  - **High throughput rates with relatively small equipment**
- **Acid leaching**
  - **Removes metal fines and molecular ionic metal smears**
  - **Uses solubilization**
  - **Uses larger equipment and has relatively slow throughput**
  - **Solubilized metals can be recovered from the leachant**
  - **Metals recovered during separation and leaching are often acceptable for off-site recycling**
- **Recovered lead can be recycled to a smelter**

ADVANTAGES OF PS/AL

- Done on site, avoiding bulk soil transport
- Metals are removed and recycled eliminating future liability
- Has been demonstrated and commercial treatment plants are available
- Treated site has broader range of beneficial uses

IMPLEMENTATION GUIDANCE HANDBOOK FOR PS/AL (draft June 97)

- Sample Hazard Analysis for H&S Plan
- Sample Work Plan Contents
- Sample QA/QC Plan
- Sample SOW for Performing PS/AL
- Technology Description
- Treatability Testing
- System Conceptual Design
- Cost Comparisons
- List of Pyrometallurgical Plants for Recycling

STEPS FOR USING PS/AL

- **Permitting**
- **Site characterization**
- **Vendor selection/contracting**
- **Bench-scale testing**
- **Site preparation**
- **Plant mobilization and operation**
- **Process verification**

VENDOR SELECTION AND CONTRACTING PS/AL

- **Vendor should have prior mining & remediation experience involving soil washing**
- **Vendors should be given a representative samples of berm soil (>30 gal) for bench testing**
- **Bench-scale testing should include all elements of the proposed process, including separation, leaching, precipitation, and dewatering**
- **Process flow diagram should show all input and output streams and mass flow rates**

BENCH-SCALE TESTING PS/AL
(TREATABILITY STUDIES)

- Prescreening Characteristics
  - Historical records
  - Site characterization results

- Establish Testing Goals and DQO
  - Determine process feasibility
  - Select physical separation approach
  - Optimize leaching system parameters
  - Determine design parameters

BENCH-SCALE TESTING PS/AL
(TREATABILITY STUDIES)

BENCH-SCALE TESTING
(TREATABILITY STUDIES)

- System Conceptual Design
  - Site planning and prep considerations
  - Soil excavation and hauling
  - Physical separation
  - Acid leaching
  - Residuals management/Soil disposal
  - Environmental considerations

SITE PREPARATION PS/AL

- Containment pad with water collection system
- Power (440V, 3-Phase)
- Water (> 50 gpm)
- Sewer discharge line

PLANT MOBILIZATION AND OPERATION

- Based on capacity of the plant (tons/hr), determine how long operation can take

- Ensure vendor has qualified operator support with knowledge of process chemistry to be able to make on-site changes

- Process control should ensure (pH, residence time, etc.) are being met. On-site laboratory support.

PROCESS VERIFICATION PS/AL

- Collect samples of processed soil. Ensure samples are large enough to be statistically accurate.
- Collect one sample every hour of the final treated material to be composited into a day's run
- Run both total and leachable metal tests
- On-site XRF can give short turnaround total lead concentrations
- Segregate treated soil batches for easy tracking (advantageous if reprocessing is necessary)
- Test Plan ESTCP Joint Small-Arms Range Demonstration at Fort Polk, LA

STABILIZATION/SOLIDIFICATION

- Reduces the mobility of heavy metals in the soil through the addition of a chemical reagent (binder)
- Metals remain in the soil matrix
- Large metal particles must be removed via screening prior to stabilization

S/S BINDERS

- Portland cement
- Portland cement and sodium silicate
- Lime and fly ash
- Phosphate

CHEMICAL PROCESSES S/S

- pH control
- Chemical reaction/binding
  - precipitation of metals as carbonates, silicates, sulfides
  - complexation
- Encapsulation
  - microencapsulation
  - macroencapsulation
- Adsorption
- Ion exchange
- Redox potential control

STEPS FOR IMPLEMENTING S/S

- Permitting
- Site characterization
- Vendor selection and contracting
- Bench-scale treatability testing
- Site preparation
- Stabilization process application
- Process verification

BENCH-SCALE TESTING FOR S/S

- Determine screening effectiveness
- Determine soil:binder ratio
- Determine water requirements, setting time, etc.
- Determine volume change after stabilization
- Ensure the physical suitability for return of processed soil to the range: soil should not set into hardened or monolithic form that may cause ricochet
- Estimate processing costs

SITE PREPARATION FOR S/S

- Relatively level firm ground near range to set up vendor’s equipment
- Asphalt or concrete pad generally not required, but vendor may lay out a geotextile on the ground under the equipment and soil piles
- Vendor generally brings power supply
- Water supply provided by base or tanker truck

S/S PLANT OPERATION

- Mobilization and demobilization are fairly quick because most plants are modular
- Plant generally includes equipment for:
  - Chemicals storage
  - Screening (to separate whole bullets and plus ¼-inch metal fragments from soil)
  - Mixing (pug mill, cement mixer, etc.)
- Residuals
  - Screened metals and gravel can be sent to a smelter for recycling
  - Any processed material that does not meet processing targets may have to be disposed of accordingly

PUG MILL

PROCESS VERIFICATION

- pH of the stabilized soil
- Leaching tests (targets determined by regulatory requirements) for closed ranges
  - TCLP
  - California WET
- Physical suitability of the stabilized material
  - Visual observation of texture (granular preferred)
  - ASTM tests
    - D-4318 for bearing capacity and critical slope

LANDFILL DISPOSAL

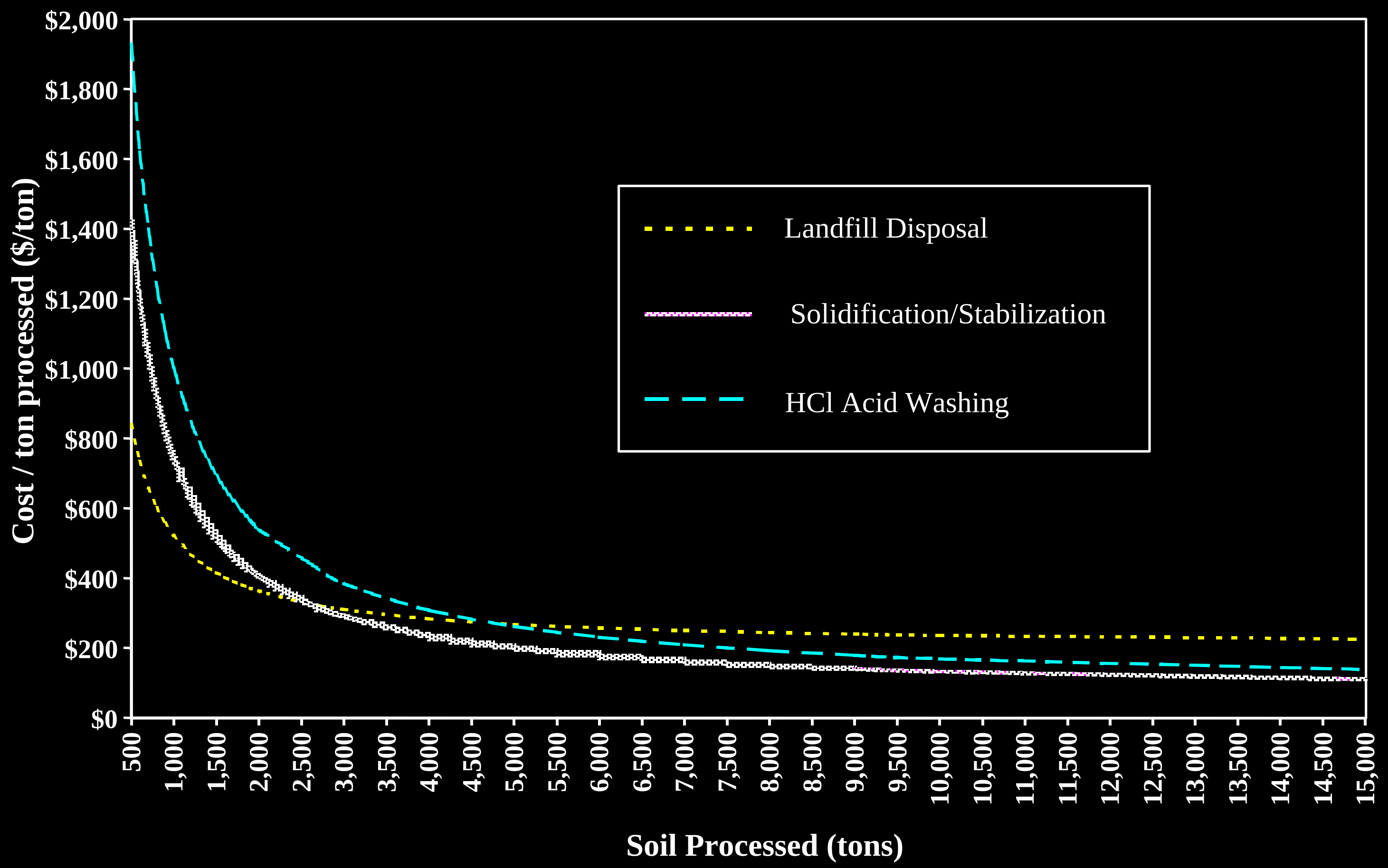
OFF SITE

- RCRA (D008 leachable lead)
- Land disposal restrictions
- High unit cost but low setup cost
- Potential for future liability

ON SITE

- For RCRA corrective action or CERCLA site can manage on site with approval of USEPA regional administrator
- Treatment in Temporary Unit (TU)
- Disposal in Corrective Action Management Unit (CAMU)
- CAMU/TU approved but may be revised in RCRA reauthorization

COST COMPARISON



ESTCP JOINT SMALL-ARMS RANGE PROJECT CASE STUDY AT FORT POLK

- Joint project with Army Environmental Center
- Demonstrated physical separation with both acetic and hydrochloric acid leaching
- Processed 263 tons with acetic acid
- Processed 835 tons with hydrochloric acid
- Fort Polk had high clay content
- Cost competitive with stabilization

CASE STUDY- FORT POLK, LA   PS/AL

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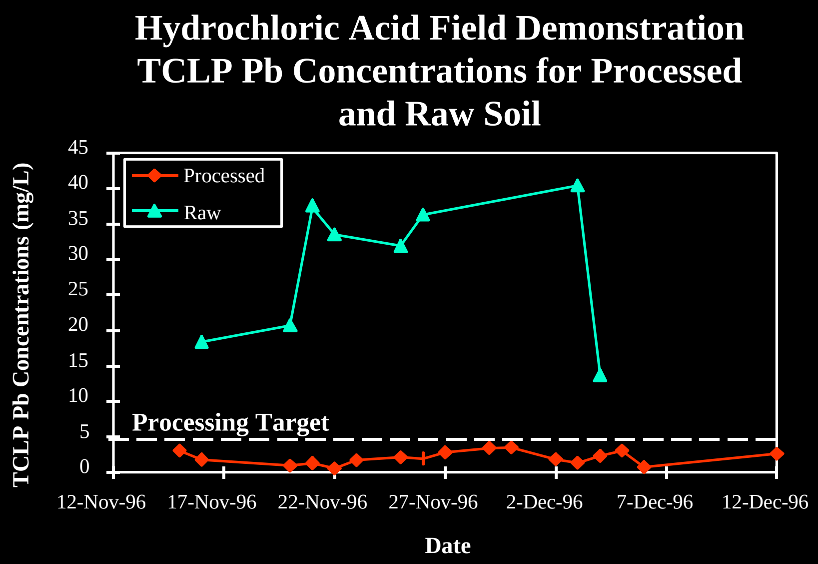

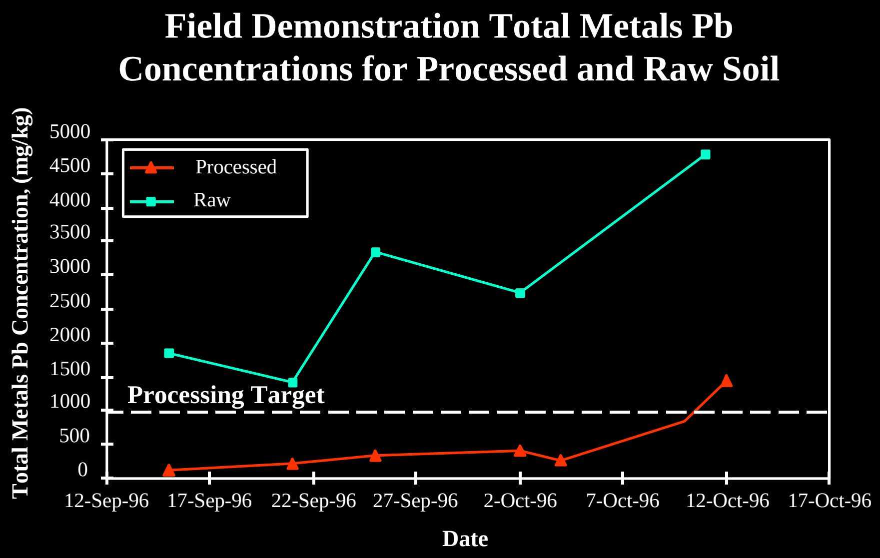

CASE STUDY AT MAYPORT

(CEMENT & SODIUM SILICATE STABILIZATION)

- **Bench-scale study determined soil:binder ratio, etc.**

- **170 cu yds of berm soil treated in 2 weeks by:**
  - **Screening (½-inch) to remove metal fragments and send to off-site smelter for recycling**
  - **Mixing in a cement mixer with 2% silicate, 20% cement, 20% water by weight of the original soil**
  - **Curing of the treated soil, initially in lined roll-off boxes for 4 hours, then spreading on the ground and breaking up lumps with a backhoe to obtain a loose, granular structure**
  - **Returning treated soil to the berm, adding a 4-inch layer of fresh soil on top, hydromulching with native grass**

- **Total project cost was around $100,000**

CASE STUDY AT MAYPORT
(CEMENT & SODIUM SILICATE STABILIZATION)

CASE STUDY AT MAYPORT
(CEMENT & SODIUM SILICATE STABILIZATION)

SOIL	Total Metals (mg/kg)			pH	TCLP Metals (mg/L)		
	Pb	Cu	Zn		Pb	Cu	Zn
Untreated	6,350-26,100	170-10,400	25-1,180	8.20-8.51	268-689	1.8-4.7	0.8-2.7
Stabilized (Pilot test 1)	2,600-11,800	80-100	25-200	12.58-12.63	< 0.5	< 0.1	< 0.1
Stabilized (Pilot test 2)	3,950-13,500	130-150	130-140	12.13-12.63	0.5	NA	NA
Stabilized (Pilot test 3)	2,750-3,700	88-120	91-130	11.91-12.62	1.3-1.4	NA	NA
Stabilized (Full-scale)	4,000-27,000	110-2,400	110-2,200	12.30-12.64	< 0.1-0.9	< 0.05-0.2	< 0.05-0.2

SMALL-ARMS RANGE PROJECTS

- S/S NAS Mayport
- PS/AL MCB Camp Pendleton
- PS/AL MCCDC Quantico
- AATDF PS/AL demo NAS Miramar
- ESTCP Joint Small-Arms Range Project at Fort Polk
- Assessments (MCB Camp Pendleton, NAWC Lakehurst, NAB Little Creek, MCCDC Quantico, MCBH Kaneohe, MCAGCC 29 Palms)
- 7 indoor range assessment/cleanups

SMALL-ARMS RANGE PUBLICATIONS

- Best Management Practices for Small-Arms Ranges (OESO)
- The Application of S/S to Waste Materials
- ESTCP Technology Demonstration Plan for Joint Small-Arms Range Remediation at Fort Polk, LA; Oct 14, 1997
- Demonstration of Physical Separation/Leaching Methods for the Remediation of Heavy Metals Contaminated Soils @ Small-Arms Ranges - World Wide Search Report; Feb 7, 1997
- Physical Separation and Acid Leaching: A Demonstration of Small-Arms Range Remediation at Fort Polk, LA (DRAFT)
- Implementation Guidance Handbook: Physical Separation and Acid Leaching to Process Small-Arms Range Soils (DRAFT)
- Technical Resource Document, The Application of Stabilization/Solidification to Waste Materials
- Remedial Options for Metals Contaminated Sites
- Environmental Effects of Small-Arms Ranges; Oct 1991

MANAGEMENT CONCLUSIONS

Practical management of potential environmental issues based on sound science is possible at outdoor small-arms ranges.

SMALL-ARMS RANGE CONTACTS

Call for information or assistance:

NFESC	**(805) 982-1668**
OESO	**(301) 743-4534**
NAVFAC Criteria Office	**(757) 322-4205**